

CLAIMS:

1. A method of interconnecting first and second elements bonded together,
comprising:

forming one mask over an exposed side of said first element;

5 using said one mask to etch said first element and expose a first contact structure
in said first element, etch through a bond interface between said first and second
elements, and expose a second contact structure in said second element; and
connecting said first and second contact structures.

2. A method as recited in claim 1, wherein exposing said first contact structure
10 comprises:

exposing a planar surface of said first contact structure; and

connecting said planar surface to said second contact structure.

3. A method as recited in claim 2, comprising:

exposing a side surface of first contact structure.

15 4. A method as recited in claim 2, comprising:

forming said first contact structure to have an aperture; and

etching through said aperture to expose said second contact structure.

5. A method as recited in claim 2, comprising:

forming said first contact structure as at least a pair of contact elements with a

20 space between said contact elements; and

etching through said space to expose said second contact structure.

6. A method as recited in claim 1, comprising:

forming said first contact structure to have an aperture; and

etching through said aperture to expose said second contact structure.

7. A method as recited in claim 1, comprising:

forming said first contact structure as at least a pair of contact structures with a space between said contact structures; and

5 etching through said space to expose said second contact structure.

8. A method as recited in claim 1,

removing at least a portion of a substrate of said first element after bonding; and performing said etching step after said removing step.

9. A method as recited in claim 1, wherein a plurality of first elements are bonded

10 to said second element, said method comprising:

forming said one mask over an exposed side of each of said first elements;

using said one mask to etch each of said first elements to expose a first contact structure in each of said first elements, etch through a bond interface between each of said first elements and said second element, and expose a plurality of second contact

15 structures in said second element; and

connecting said first and second contact structures.

10. A method as recited in claim 9, comprising:

removing at least a portion of a substrate of each of said first elements after bonding; and

20 performing said etching step after said removing step.

11. A method as recited in claim 1, wherein said connecting step comprises:

forming a metal seed layer in contact with said first and second contact structures;

and

forming a metal contact on said metal seed layer.

12. A method as recited in claim 11, comprising:
chemo-mechanically polishing said metal contact and said first element after
forming said metal contact.

5 13. A method as recited in claim 1, comprising:
forming a dielectric layer on said first element;
forming said mask on said dielectric layer.

14. A method as recited in claim 1, comprising:
forming said mask directly on said exposed side of said first element.

10 15. A method as recited in claim 1, comprising:
forming said mask over a backside of said first element;
exposing a back surface of said first contact structure; and
exposing a top surface of said second contact structure.

16. A method as recited in claim 1, comprising:
15 forming a via in said first element during said etching step;
forming a dielectric layer on sidewalls of said via; and
etching said dielectric layer to expose said first and second contact structures.

17. A method as recited in claim 16, comprising:
forming a metal seed layer over said dielectric layer and in contact with said first
20 and second contact structures; and

forming a metal contact on said metal seed layer.

18. A method as recited in claim 1, comprising:
forming a first via in said first element using said mask; and

forming a second via in said second element using said first contact structure.

19. A method as recited in claim 1, wherein said first element comprises a first device having said first contact structure and said second element comprises a second device having said second contact structure.

5 20. A method as recited in claim 1, wherein said first element comprises a first device having said first contact structure and said second element comprises a module having a plurality of connection structures including said second contact structure.

21. A method as recited in claim 1, comprising:

forming said mask to have an edge portion formed over said first contact structure
10 and a second edge portion formed over said second contact structure and not over said first contact structure.

22. A method as recited in claim 1, comprising:

bonding said first element to said second element such that said first contact structure directly contacts said second contact structure.

15 23. A method as recited in claim 1, wherein a plurality of first elements are bonded to said second element, said method comprising:

forming said one mask over an exposed side of each of said first elements;

using said one mask to etch each of said first elements to expose a first contact structure in each of said first elements, etch through a bond interface between each of
20 said first elements and said second element, and expose a plurality of second contact structures in said second element; and

connecting said first and second contact structures.

24. A method as recited in claim 23, comprising:

connecting a plurality of first contact structures to a respective plurality of second contact structures.

25. A method as recited in claim 1, comprising:

stopping said etch after exposing said first contact structure;

5 forming a mask material on said first contact structure; and

resuming said etch after said forming step to expose said second contact structure.

26. A method as recited in claim 25, wherein said forming step comprises electroless plating said first contact structure with a metal material.

27. A method of connecting a first device having a first substrate portion to an
10 element, said first device bonded to said element such that said substrate portion of said first device is exposed, comprising:

forming a first mask over said substrate portion;

etching said first device using said first mask to expose a first contact structure in
said first device; and

15 etching using said first contact structure as a second mask to expose a second contact structure in said element; and

connecting said first and second contact structures.

28. A method as recited in claim 27, wherein exposing said first contact structure comprises:

20 exposing a planar surface of said first contact structure; and

connecting said planar surface to said second contact structure.

29. A method as recited in claim 28, comprising:

exposing a side surface of first contact structure.

30. A method as recited in claim 28, comprising:

forming said first contact structure to have an aperture; and

etching through said aperture to expose said second contact structure.

31. A method as recited in claim 28, comprising:

5 forming said first contact structure as at least a pair of contact elements with a space between said contact elements; and

etching through said space to expose said second contact structure.

32. A method as recited in claim 27, comprising:

forming said first contact structure to have an aperture; and

10 etching through said aperture to expose said second contact structure.

33. A method as recited in claim 27, comprising:

forming said first contact structure as at least a pair of contact structures with a space between said contact structures; and

etching through said space to expose said second contact structure.

15 34. A method as recited in claim 27, comprising:

removing at least a portion of a substrate of said first device after bonding; and performing said etching step after said removing step.

35. A method as recited in claim 27, wherein a plurality of first devices are bonded to said element, said method comprising:

20 forming said one mask over an exposed side of each of said first devices;

using said one mask to etch each of said first elements to expose a first contact structure in each of said first elements, etch through a bond interface between each of

said first elements and said element, and expose a plurality of second contact structures in said element; and

connecting said first and second contact structures.

36. A method as recited in claim 35, comprising:

5 removing at least a portion of a substrate of each of said first elements after bonding; and

performing said etching step after said removing step.

37. A method as recited in claim 35, comprising:

10 connecting a plurality of first contact structures to a respective plurality of second contact structures.

38. A method as recited in claim 27, wherein said connecting step comprises:

forming a metal seed layer in contact with said first and second contact structures; and

forming a metal contact on said metal seed layer.

15 39. A method as recited in claim 27, comprising:

chemo-mechanically polishing said first device after forming said metal contact.

40. A method as recited in claim 27, comprising:

forming a dielectric layer on said first device;

forming said mask on said dielectric layer.

20 41. A method as recited in claim 27, comprising:

forming said mask over a backside of said first device;

exposing a back surface of said first contact structure; and

exposing a top surface of said second contact structure.

42. A method as recited in claim 27, comprising:
forming a via in said first device during said etching step;
forming a dielectric layer on sidewalls of said via; and
etching said dielectric layer to expose said first and second contact structures.

5 43. A method as recited in claim 42, comprising:
forming a metal seed layer over said dielectric layer and in contact with said first
and second contact structures; and
forming a metal contact on said metal seed layer.

44. A method as recited in claim 27, comprising:
10 forming a first via in said first device using said mask; and
forming a second via in said element using said first contact structure.

45. A method as recited in claim 27, wherein said element comprises a module
having a plurality of connection structures including said second contact structure.

46. A method as recited in claim 27, comprising:
15 bonding said first device to said element such that said first contact structure
directly contacts said second contact structure.

47. A method as recited in claim 27, comprising:
after etching said first device to expose said first contact structure;
forming a mask material on said first contact structure; and
20 etching using said first contact structure as a second mask to expose a second
contact structure in said element after said step of forming a mask material.

48. A method as recited in claim 47, wherein said step of forming a mask
material comprises electroless plating said first contact structure with a metal material.

49. A device comprising:

a first element having a first contact structure;

a second element having a second contact structure;

said first element bonded to said second element;

5 a first via formed in said first element and extending from a back surface of said first element to said first contact structure;

a second via extending from said first contact structure to said second contact structure and communicating with said first via; and

a contact member connected to said first and second contact structures.

10 50. A device as recited in claim 49, comprising:

said first contact structure having a planar surface connected to said contact member.

51. A device as recited in claim 49, comprising:

15 said first contact structure having a planar surface and a side surface connected to said contact member.

52. A device as recited in claim 49, comprising:

said first contact structure having an aperture; and

said contact member extending through said aperture to second contact structure.

53. A device as recited in claim 49, comprising:

20 said first contact structure comprising at least a pair of contact structures with a space between said contact structures; and

said contact member extending through said space to said second contact structure.

54. A device as recited in claim 49, comprising:

a back surface of said first contact connected to said contact member.

55. A device as recited in claim 49, comprising:

a dielectric film formed on sides of each of said first and second vias; and

5 said contact member comprising a first metal layer formed on said dielectric film
and a second metal layer formed on said first metal layer.

56. A device as recited in claim 49, comprising:

a mask formed on said first element.

57. A device as recited in claim 56, comprising:

10 said mask having a high etch selectivity to material etched from said first element
to form said first via.

58. A device as recited in claim 57, comprising:

said mask having a high etch selectivity to material etched from said second
element to form said second via.

15 59. A device as recited in claim 57, comprising:

said mask comprising at least one or a combination of aluminum, tungsten,
platinum, nickel, or molybdenum.

60. A device as recited in claim 56, comprising:

said first contact structure having an aperture;

20 said mask defining a width of said first via; and

said aperture defining a width of said second via.

61. A device as recited in claim 49, wherein:

said first element is a first semiconductor device; and

said second element is one of second semiconductor device and a module.

62. A device as recited in claim 49, comprising:

said first contact structure directly connected to said second contact structure.

63. A device as recited in claim 49, comprising:

5 a mask material formed on said first contact structure.

64. A device as recited in claim 49, comprising:

an electroless plated layer formed on said first contact structure.